Third Secondary

Chapter 1

MIND MAP SUMMARY – TRANSITION ELEMENTS

FIRST TRANSITION SERIES (Sc to Zn), 4TH PERIOD

21	22	23	24	25	26	27	28	29	30
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc

Transition Elements

d-block elements with partially filled d-orbitals

KEY CHARACTERISTICS

- Variable oxidation states +2 +3 +6
- Coloured ions and compounds

- Paramagnetism/ diamagnetism

- Catalytic activity

- High economic importance

ECONOMIC IMPORTANCE

Industry: catalysts, machinery, chemical processes

Electronics: components, magnets, batteries

Agriculture: fertilisers, micronutrients (e.g., Mn, Zn)

Alloys: stainless steel, nichrome, high-strength materials

Currency & coins: Cu, Ni and their alloys

1 LESSON 1 – First transition series elements and their uses

- Properties across Sc to Zn
- Occurrence and extraction
- Important uses

2 LESSON 2 – General properties

- Atomic & ionic radii
- Ionisation enthalpy
- Electrode potentials
- Complex formation
- Magnetic behaviour
- Catalytic activity

3 LESSON 3 – Iron, extraction, steel and alloys

- Extraction of iron
- Blast furnace process
- Properties of steel
- Types and uses of alloys

4 LESSON 4 – Iron oxides

- Properties of iron oxides
- Reactions and reductions
- Importance of oxides

IN SUMMARY

Transition elements are d-block elements with partially filled d-orbitals. → They show variable oxidation states and form coloured compounds. → They exhibit magnetic behaviour and act as excellent catalysts. → They are vital to industry, technology, agriculture and daily life. → Studying them helps us understand nature and build a better future.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Third Secondary

Chapter 1

LESSON 1 – Scandium and Titanium

First transition series elements and their uses

FIRST TRANSITION SERIES (Sc to Zn), 4TH PERIOD

21	22	23	24	25	26	27	28	29	30
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc

Scandium and Titanium

SCANDIUM (Sc)

Occurrence

Occurs in very small amounts spread over large areas in the earth's crust.

Mercury vapour lamps

Used in mercury vapour lamps for TV photography to produce light similar to sunlight.

Aluminium–scandium alloy

A small amount added to aluminium produces a light, hard alloy used in MIG fighter jets.

TITANIUM (Ti)

Strong and light

As strong and rigid as steel but less dense.

High-temperature durability

Maintains durability at high temperatures.

Medical implants

Used in dental implants and artificial joints because it is rigid, inert and nonpoisonous, so the body does not reject it.

Aerospace applications

Titanium–aluminium alloys are used in aircraft and space shuttles because they maintain durability at high temperatures.

Titanium dioxide (TiO_2)

TiO_2 is used in sun-protection cosmetics because its fine particles protect the skin from ultraviolet rays.

WHY THEY MATTER

- Excellent strength-to-weight ratio
- Corrosion resistance
- High melting points and durability
- Important in modern technology and advanced materials

IN SUMMARY

- **Sc** Scandium: rare element; used in special lamps and in lightweight aluminium alloys for aircraft.
- **Ti** Titanium: strong, light and durable; withstands high temperatures.
- Medical uses: rigid, inert and nonpoisonous—ideal for dental implants and artificial joints.
- Aerospace: Ti–Al alloys used in aircraft and space shuttles.
- TiO_2 protects skin from UV rays in sun-protection cosmetics.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Third Secondary

Chapter 1

LESSON 1 – VANADIUM TO ZINC

First transition series elements and important uses

FIRST TRANSITION SERIES (V to Zn), 4TH PERIOD							
23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc

First Transition Series (V to Zn)

23 V Vanadium

- Strong steel alloys
- Springs and tools
- Vanadium(V) oxide, V_2O_5, as catalyst in the Contact Process for making sulfuric acid

24 Cr Chromium

- Stainless steel
- Chrome plating
- Pigments
- Leather tanning

25 Mn Manganese

- Important in the steel industry
- Dry cells / batteries
- Manganese dioxide in cells

26 Fe Iron

- Major industrial metal used in structures, machinery and tools

27 Co Cobalt

- Strong alloys with heat resistance
- Blue-colored glass and ceramics

28 Ni Nickel

- Stainless steel
- Coinage
- Industrial alloys

29 Cu Copper

- First discovered metal
- Copper–tin alloy is bronze
- Electric cables because copper is a good conductor
- Coinage
- Important compounds:
  - Copper(II) sulfate, $CuSO_4$, used as fungicide and in water purification
  - Fehling's solution used to detect glucose because blue color changes to orange

30 Zn Zinc

- Galvanization protects iron from rusting
- Zinc oxide, ZnO, used in paints, rubber and cosmetics
- Zinc sulfide, ZnS, used in illuminating paints

IN SUMMARY

All first transition series elements (V to Zn) are metals with variable oxidation states.

They form strong alloys that are essential to industry, technology and daily life.

Many form important compounds used in catalysis, protection, medicine and analysis.

Their unique properties and uses drive modern industry, innovation and human progress.

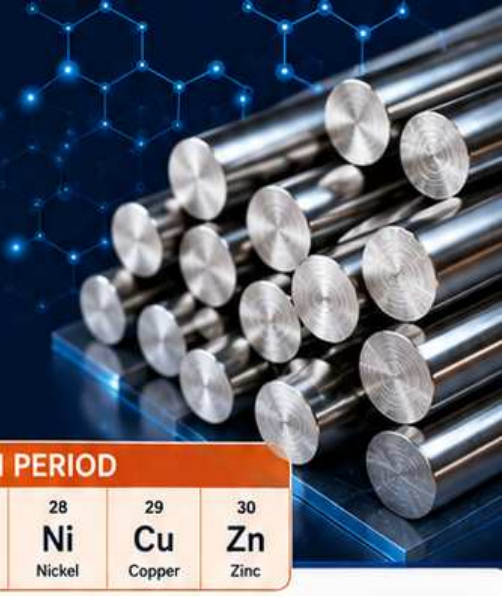
D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Third Secondary

Chapter 1

LESSON 2 – GENERAL PROPERTIES

General properties of the first transition series elements



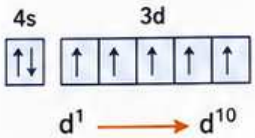
FIRST TRANSITION SERIES (Sc to Zn), 4TH PERIOD

21	22	23	24	25	26	27	28	29	30
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc

1 GENERAL ELECTRONIC STRUCTURE OF FIRST TRANSITION SERIES ELEMENTS

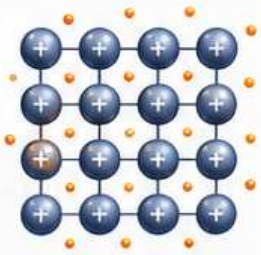
$[Ar]\ 3d^{1-10}\ 4s^{1-2}$

- The general electronic configuration is $[Ar]\ 3d^{1-10}\ 4s^{1-2}$.
- 4s electrons are lost first in forming cations.
- 3d electrons are progressively filled from Sc to Zn.



2 STRONG METALLIC BONDING

- Many delocalized electrons from 4s and 3d orbitals.
- These electrons are held together by a lattice of positive metal ions.



General Properties

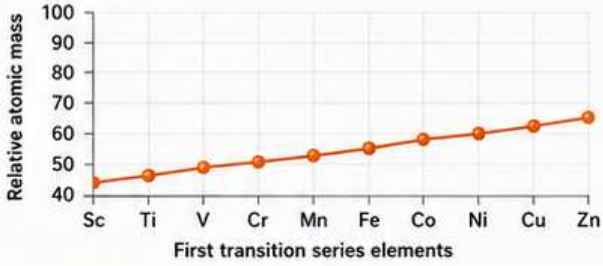
3 METALLIC PROPERTIES

- Strong and hard metals.
- High melting and boiling points.
- Good conductors of heat and electricity.
- Mostly silvery grey and lustrous, except copper (reddish-brown).

High melting & boiling points | Good electrical conductors | Good thermal conductors | Lustrous appearance

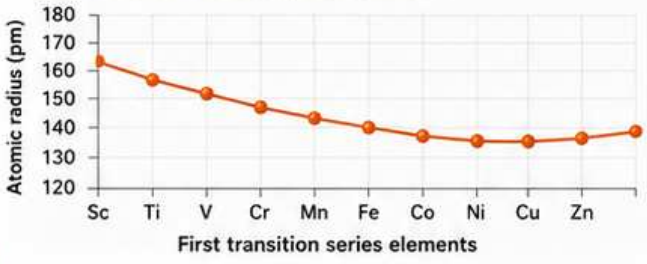
4 ATOMIC MASS

- Atomic mass gradually increases from Sc to Zn.



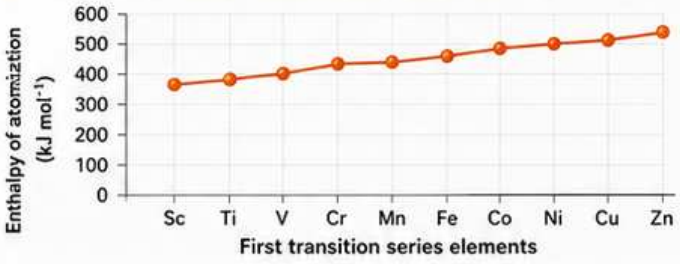
5 ATOMIC RADIUS

- Small gradual decrease across the series, then almost constant or slight rise towards Zn.



6 HEAT CHANGE / BOND STRENGTH INDICATOR / ENTHALPY OF ATOMIZATION

- Relatively high values, reflecting strong metallic bonding.



KEY TAKEAWAY

- First transition elements have partially filled 3d orbitals.
- Strong metallic bonding gives rise to typical metallic properties.
- Trends in atomic mass, radius and bond strength are systematic.
- These general properties explain their reactivity and many applications.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Third Secondary

Chapter 1

LESSON 2 –

VARIABLE OXIDATION STATES, MAGNETIC PROPERTIES, COLOURED IONS AND CATALYTIC ACTIVITY

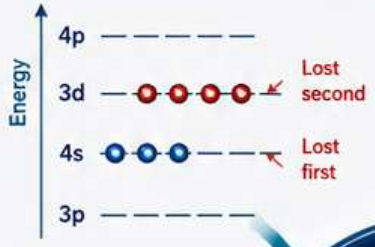
FIRST TRANSITION SERIES (Sc to Zn), 4TH PERIOD

21	22	23	24	25	26	27	28	29	30
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc

Special Properties of Transition Elements

1 VARIABLE OXIDATION STATES

- Electrons can be lost from both 4s and 3d orbitals.
- 4s electrons are lost first, then 3d electrons.
- Therefore, many oxidation states appear across the first transition series.



COMMON OXIDATION STATES

+2 +3 +6

EXAMPLES IN THE SERIES

V	Cr	Fe
Vanadium	Chromium	Iron
+2, +3, +4, +5	+2, +3, +6	+2, +3, +6

2 MAGNETIC PROPERTIES

- Magnetic behaviour depends on the number of unpaired d-electrons.
- Two main types:

Paramagnetism (attracted to a magnetic field)

Diamagnetism (not attracted; weakly repelled)

- Most transition metal ions are paramagnetic (have unpaired d-electrons).
- Sc^{3+} ($3d^0$) and Zn^{2+} ($3d^{10}$) have no unpaired d-electrons and are diamagnetic.

Sc^{3+} ($3d^0$) Diamagnetic

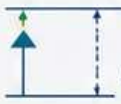
Zn^{2+} ($3d^{10}$) Diamagnetic

3 COLOURED IONS AND COMPOUNDS

- Colours arise from d–d electronic transitions when visible light is absorbed.
- Different ions absorb different wavelengths, so they appear in different colours.

$[Ti(H_2O)_6]^{3+}$	$[Cr(H_2O)_6]^{3+}$	$[Cu(H_2O)_6]^{2+}$	$[Fe(CN)_6]^{4-}$
Purple	Green	Blue	Yellow

Visible light absorbed



Different energy gaps give different colours.

4 CATALYTIC ACTIVITY

- Transition metals and their compounds are excellent catalysts because of their variable oxidation states and ability to form intermediate compounds.
- They lower activation energy and speed up reactions without being consumed.

IMPORTANT INDUSTRIAL CATALYTIC PROCESSES

Haber process (ammonia synthesis)

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

Catalyst: Iron (Fe)

Contact process (manufacture of H_2SO_4)

$2SO_2 + O_2 \rightleftharpoons 2SO_3$

Catalyst: Vanadium(V) oxide (V_2O_5)

Hydrogenation (e.g., vegetable oils)

$RCH{=}CHR' + H_2 \rightarrow RCH_2{-}CH_2R'$

Catalyst: Nickel (Ni)

KEY TAKEAWAYS

Variable oxidation states arise from loss of 4s electrons first, then 3d electrons, giving many oxidation states.

Magnetic properties depend on unpaired d-electrons; most ions are paramagnetic, Sc^{3+} and Zn^{2+} are diamagnetic.

Coloured ions result from d–d electronic transitions that absorb visible light.

Catalytic activity stems from variable oxidation states and intermediate complex formation.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Third Secondary

Chapter 1

LESSON 3 –

Iron in Nature and Ore Preparation

FIRST TRANSITION SERIES (Sc to Zn), 4TH PERIOD									
21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc

1 IRON OVERVIEW

- Atomic number: 26
- Electron configuration: $[Ar]\ 4s^2\ 3d^6$
- Common oxidation states: +2 and +3

IRON IN NATURE

- Iron is the fourth most abundant element in the earth's crust.
- It forms about 5.1% of the earth's crust by mass.
- Not found free in nature except in meteorites.
- Usually found in ores.

Iron in Nature and Ore Preparation

3 MAIN ORES OF IRON

	Siderite (iron(II) carbonate)	$FeCO_3$
	Limonite (hydrated iron(III) oxide)	$2Fe_2O_3 \cdot 3H_2O$ (or hydrated iron(III) oxide)
	Hematite (iron(III) oxide)	Fe_2O_3
	Magnetite (iron(II,III) oxide)	Fe_3O_4

ORE PREPARATION STEPS

1. **Crushing**
   Large ore rocks are broken into smaller pieces (5–20 cm) using crushers.

2. **Sintering**
   Finely crushed ore is heated below its melting point with fluxes to form porous sintered lumps.

3. **Concentrating**
   Removal of gangue (impurities) to increase the iron content using methods like magnetic separation.

4. **Roasting**
   Heated strongly in the presence of excess air to drive off moisture, volatile impurities and oxidize the ore.

The suitability of an ore for extraction depends mainly on its iron percentage and the amount and nature of impurities present.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Third Secondary

Chapter 1

LESSON 3

Extraction of Iron, Steel and Alloys

1 EXTRACTION OF IRON FROM HEMATITE (Fe_2O_3) BY REDUCTION

- Iron in nature is found in combined form, mostly as iron oxides such as hematite (Fe_2O_3). It is extracted by reduction—removal of oxygen using a reducing agent such as carbon monoxide (CO) or carbon (C).

Fe_2O_3 (Hematite) $\xrightarrow[\text{(Heat)}]{\text{CO / C}}$ Fe (Iron)

2 BLAST FURNACE PROCESS

CHARGES

- **Iron ore** (Hematite, Fe_2O_3)
- **Coke** (Carbon, C)
- **Limestone** ($CaCO_3$)

KEY EQUATIONS

- $C + O_2 \rightarrow CO_2$ (Combustion)
- $CO_2 + C \rightarrow 2CO$ (Formation of CO)
- $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ (Reduction)
- $CaCO_3 \rightarrow CaO + CO_2$ (Calcination)
- $CaO + SiO_2 \rightarrow CaSiO_3$ (Formation of slag)

PRODUCTS

- **Pig Iron** (Fe with 3–4% C and other impurities)
- **Slag** ($CaSiO_3$, impurities) Floats on top, removed

3 MIDREX FURNACE / DIRECT REDUCTION

- Natural gas (CH_4) and steam (H_2O) are used to produce synthesis gas (water gas: $H_2 + CO$).
- This gas reduces iron oxides directly to sponge iron without melting.

PROCESS

Natural gas (CH_4) + Steam (H_2O)
↓
Water gas ($H_2 + CO$)
($H_2O + C \rightarrow H_2 + CO$)
↓
Iron ore (Fe_2O_3 / Fe_3O_4) + H_2 / CO
↓
Sponge Iron (Porous iron, ~96% Fe)

Iron Extraction and Alloys

4 PRODUCTION OF STEEL

- Pig iron is refined to remove impurities and adjust carbon content to make steel.

OXYGEN CONVERTER (BASIC OXYGEN FURNACE)

- Molten pig iron + scrap + O_2 blown at high pressure.
- Impurities oxidised and removed.
- Fast process (15–20 min).

OPEN-HEARTH FURNACE (SIEMENS–MARTIN)

- Reverberatory furnace using air or oxygen.
- Good control of composition.
- Now less commonly used.

ELECTRIC ARC FURNACE (EAF)

- Electric arc melts scrap steel.
- High temperature (> 1600 °C).
- Clean and energy efficient.

STEEL FEATURES

- Stronger than cast iron
- Lower carbon (0.1–1.5%)
- Malleable, ductile, tough

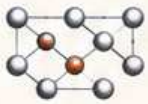
5 ALLOYS – SUMMARY

An alloy is a mixture of two or more elements, at least one of which is a metal, or a metal with a nonmetal.

INTERSTITIAL ALLOYS

Small non-metal atoms fit into interstitial spaces in the metal lattice.

Example: Steel (C in Fe)



SUBSTITUTION ALLOYS

One metal atom replaces another metal atom in the lattice.

Example: Brass (Cu + Zn)

INTERMETALLIC ALLOYS

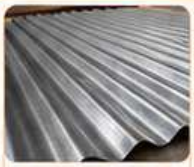
Fixed composition compounds of metals with ordered structures.

Example: Cu_3Au (Copper gold)

COMMON ALLOYS & EXAMPLES

Brass (Cu + Zn)
Used in taps, musical instruments, decorative items.

Bronze (Cu + Sn)
Used in statues, bearings, medals.



Galvanized Iron (Fe coated with Zn)
Used in roofing sheets, pipes.

Stainless Steel (Fe + Cr + Ni)
Corrosion resistant. Used in cutlery, sinks, appliances.

KEY TAKEAWAY

- Iron is extracted mainly in blast furnaces by reduction of iron oxides.
- Direct reduction (MIDREX) produces sponge iron.
- Steel is produced by removing impurities and controlling carbon.
- Alloys improve properties and are essential in industry.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Third Secondary

Chapter 1

LESSON 4 –

IRON OXIDES OVERVIEW

IRON OXIDES: THREE MAIN FORMS, MANY CONNECTIONS

21	22	23	24	25	26	27	28	29	30
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc

Iron Oxides

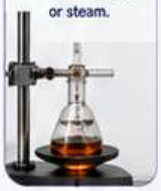
Three important oxides of iron with different compositions, structures and properties.

FeO — IRON(II) OXIDE FERROUS OXIDE

- Formula: FeO
- Colour: Black
- Oxidation state of Fe: +2
- Less stable; easily oxidised to Fe_2O_3.

PREPARATION

Heating Fe in limited oxygen or steam.



PROPERTIES

- Black solid
- Basic oxide
- Poorly soluble in water.

REACTIONS (See next pages)

- Oxidised by O_2 to Fe_2O_3
- Reacts with acids.

Fe_2O_3 — IRON(III) OXIDE FERRIC OXIDE

- Formula: Fe_2O_3
- Colour: Red (reddish-brown)
- Oxidation state of Fe: +3
- Main ore of iron: Hematite (Fe_2O_3)
- Important red pigment.

PREPARATION

Strong heating of $Fe(OH)_3$, FeOOH or iron-containing compounds in air.

PROPERTIES

- Red solid
- Basic oxide
- Insoluble in water
- Stable to air and heat.

REACTIONS (See next pages)

- Does not react with water
- Reacts with acids
- Can be reduced to lower oxides.

Fe_3O_4 — MAGNETIC IRON OXIDE MAGNETITE

- Formula: Fe_3O_4
- Colours: Black
- Mixed oxide: $FeO \cdot Fe_2O_3$ (Fe^{2+} and Fe^{3+} ions present)
- Strongly magnetic.
- Occurs naturally as magnetite.

PREPARATION

Heating Fe in oxygen or by reducing Fe_2O_3 partially.

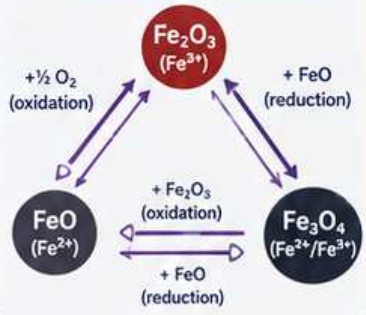
PROPERTIES

- Black solid
- Magnetic
- Moderately basic
- Very low solubility in water.

REACTIONS (See next pages)

- Can be oxidised to Fe_2O_3
- Can be reduced to FeO.

RELATIONSHIPS BETWEEN IRON OXIDES



IN SUMMARY

FeO: Black, Fe^{2+} oxide. Less stable, easily oxidised to Fe_2O_3.

Fe_2O_3: Red, Fe^{3+} oxide. Main iron ore (hematite) and red pigment.

Fe_3O_4: Black, mixed oxide $FeO \cdot Fe_2O_3$. Strongly magnetic (magnetite).

These oxides interconvert through oxidation and reduction reactions – the basis of iron extraction and many industrial processes.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Third Secondary

Chapter 1

LESSON 4 – PREPARATION AND PROPERTIES OF IRON OXIDES

1 IRON(II) OXIDE – FeO

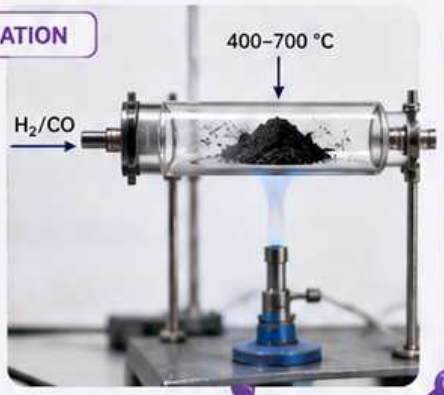
PREPARATION

- Heating iron(II) oxalate in the absence of air.

$$FeC_2O_4 \xrightarrow{\Delta \text{ (no air)}} FeO + CO + CO_2$$

- Reduction of higher oxides by H_2 or CO at 400–700 °C.

$$Fe_2O_3 + H_2 \longrightarrow 2FeO + H_2O$$
$$Fe_3O_4 + H_2 \longrightarrow 3FeO + H_2O$$
$$Fe_2O_3 + CO \longrightarrow 2FeO + CO_2$$



PROPERTIES

- Black powder
- Insoluble in water
- Easily oxidized in hot air to Fe_2O_3.

$$4FeO + O_2 \xrightarrow[\text{(hot air)}]{} 2Fe_2O_3$$

- Reacts with dilute mineral acids to form iron(II) salts and water.

$$FeO + 2HCl \longrightarrow FeCl_2 + H_2O$$

FeO (black powder)

2 IRON(III) OXIDE – Fe_2O_3

PREPARATION

- Heating iron(II) hydroxide.

$$2Fe(OH)_3 \xrightarrow{\Delta} Fe_2O_3 + 3H_2O$$

- Heating iron(II) sulfate.

$$2FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2 + SO_3$$

- Oxidation of FeO in hot air.

$$4FeO + O_2 \xrightarrow[\text{(hot air)}]{} 2Fe_2O_3$$

- Heating Fe_3O_4 in air.

$$4Fe_3O_4 + O_2 \longrightarrow 6Fe_2O_3$$

Preparation and Properties

PROPERTIES

- Red powder
- Insoluble in water
- Used as a red pigment in paints.

- Reacts with hot concentrated mineral acids to form iron(III) salts.

$$Fe_2O_3 + 6HCl \text{ (hot)} \longrightarrow 2FeCl_3 + 3H_2O$$

Fe_2O_3 (red powder)

3 IRON(II,III) OXIDE – Fe_3O_4

PREPARATION

- Reaction of red-hot iron with air or steam.

$$3Fe + 2O_2 \xrightarrow[\text{(red hot)}]{} Fe_3O_4$$

or

- Reduction of Fe_2O_3 by CO.

$$3Fe_2O_3 + CO \longrightarrow 2Fe_3O_4 + CO_2$$

PROPERTIES

- Black powder
- Strong magnet.

- Reacts with hot concentrated acids to give iron(II) and iron(III) salts.

$$Fe_3O_4 + 8HCl \text{ (hot)} \longrightarrow FeCl_2 + 2FeCl_3 + 4H_2O$$

- Oxidized in air to Fe_2O_3.

$$4Fe_3O_4 + O_2 \longrightarrow 6Fe_2O_3$$

- Reduced by H_2 or CO to FeO.

$$Fe_3O_4 + 4H_2 \longrightarrow 3FeO + 4H_2O$$
$$Fe_3O_4 + CO \longrightarrow 3FeO + CO_2$$

Fe_3O_4 (black powder)

SUMMARY

FeO
- Black, easily oxidized in air.
- Reacts with dilute acids → Fe(II) salts.

Fe_2O_3
- Red, stable, used as red pigment.
- Reacts with hot conc. acids → Fe(III) salts.

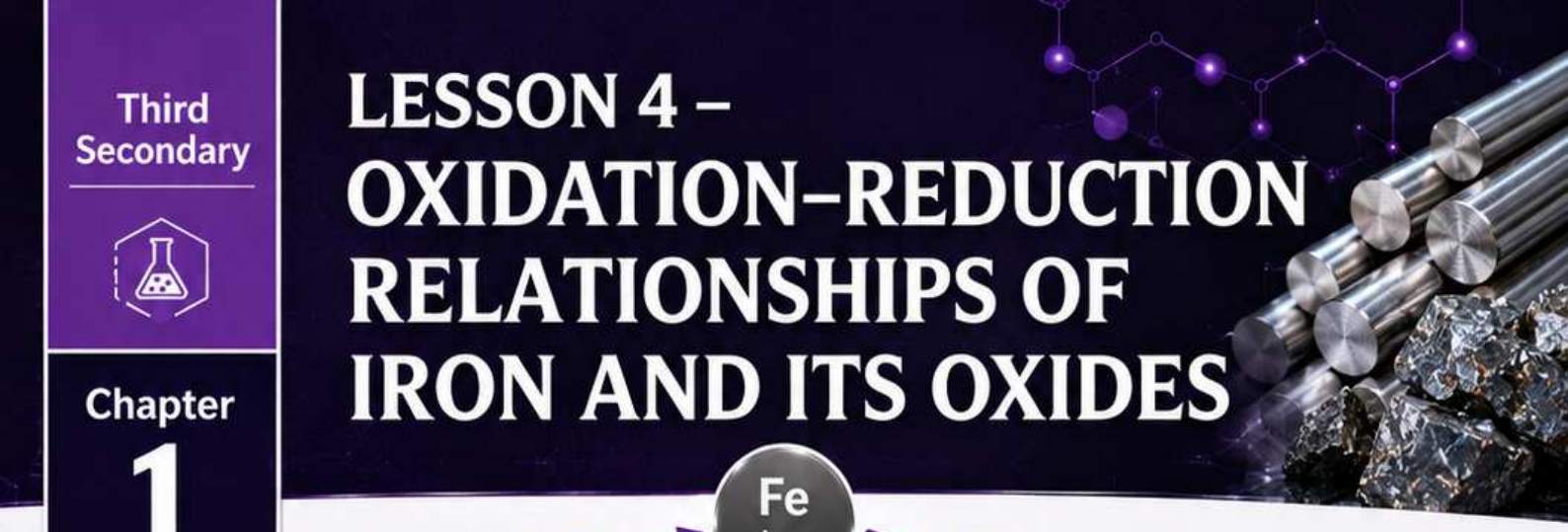
Fe_3O_4
- Black, magnetic.
- Can be oxidized to Fe_2O_3 or reduced to FeO.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Third Secondary

Chapter 1

LESSON 4 – OXIDATION–REDUCTION RELATIONSHIPS OF IRON AND ITS OXIDES



Oxidation of FeO

FeO (wüstite) is further oxidised by oxygen to form Fe_2O_3 (hematite).

$4FeO + O_2 \rightarrow 2Fe_2O_3$

Fe_3O_4: Mixed Oxide

Magnetite is a mixed oxide with formula $FeO \cdot Fe_2O_3$ (Fe^{2+} and Fe^{3+}).

Fe_2O_3: Hematite

Hematite is the main ore of iron and the most stable oxide.

Also used as a red/brown pigment.

Reducing Agents

Hydrogen (H_2) and carbon monoxide (CO) remove oxygen from iron oxides.

COMPARISON OF IRON OXIDES

Property	FeO (Wüstite)	Fe_3O_4 (Magnetite)	Fe_2O_4 (Hematite)
Name	Wüstite	Magnetite	Hematite
Formula	FeO	Fe_3O_4	Fe_2O_3
Colour	Black–grey	Black	Red–brown
Magnetic property	Weakly magnetic (antiferromagnetic)	Strongly magnetic	Not magnetic
Reaction with acids	Reacts with acids to form Fe^{2+} salts and H_2	Reacts with acids to form Fe^{2+}/Fe^{3+} salts and H_2	Reacts with acids to form Fe^{3+} salts and H_2
Main uses	Intermediate in iron extraction; reacts to form magnetite and hematite	Main iron ore (e.g., magnetite ore); used in transformers, magnetic materials, water purification	Main iron ore (hematite ore); pigments (red/brown); polishing compound (jeweller's rouge)

CHAPTER 1 IN SUMMARY

1. First Transition Series

Includes elements from Sc (21) to Zn (30) in the 4th period.

2. General Properties

Arise due to partially filled d-orbitals leading to variable oxidation states, coloured ions, magnetism and catalytic activity.

3. Iron: Extraction & Alloys

Iron is extracted from its oxides using reducing agents (C/CO/H_2) and is used to make useful alloys like steel and stainless steel.

4. Iron Oxides

FeO, Fe_2O_4 and Fe_2O_3 are important iron oxides with distinct properties and wide industrial uses.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

موقع الدكتور محمد رزق التعليمي

امسح الباركود بالموبيل لتثبيت التطبيق وتحميل كل الملازم مجانا وبسرعه

MR

حمل التطبيق الأن

GET IT ON Google Play

ملازم ابتدائي | ملازم اعدادي | ملازم ثانـــوي | كورسات ونتائج امتحانات

موقع الدكتور محمد رزق
Dr.MoRizK